The Agent in Magenta: Action, Colour and Consciousness

The 'Agent' in Magenta: Action, Color and Consciousness

Abstract

How should we understand the relationship between conscious perception and action? Does an appeal to action have any place in an account of color experience? This essay aims to shed light on the first question by giving a positive response to the second. I consider two types of enactive approach to perceptual consciousness, and two types of account of color perception. Each approach to color perception faces serious objections. However, the two views can be combined in a way that resists the criticisms to each. Furthermore, the hybrid view we arrive at lets us see which enactive account of perceptual consciousness we should prefer in the case of color.

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Enacting Experience

Much recent work on perception and consciousness aims to honor the intuitive observation that whenever we seem to find flexible and intelligent agency, we also find conscious experience (Varela, Thompson and Rosch, 1991) (Hurley, 1998) (Noë, 2004) (Thompson, 2007). Such an intuition is one motivation amongst many for developing a theory of conscious perception that makes essential reference to the skilled activity of the perceiver – such theories can also make sense of much current work in cognitive science, provide new perspectives on problems faced by traditional approaches to perception, action and cognition, and do justice to the involved and skillful nature of worldly perception and consciousness. Suppose we grant that an appeal to action is necessary for an understanding of perception – what form should such an appeal take?

One option is pursued by Alva Noë (2004).[2] According to Noë, the content and character of our visual experience is determined by our practical ability to understand and keep track of systematic ways in which our perceptual stimulation changes with certain of our bodily movements. For example, a visually perceived tomato appears spherical (rather than as a circular tomato-façade) if the perceiver possesses implicit knowledge of how her sensations would change were she to move around it. And the tomato is experienced as visually rather than tactually presented if the perceiver implicitly knows that (for example) moving her head and eyes around will alter her visual sensations in characteristic ways, while leaving her tactile sensations unchanged.

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[2] Other sensorimotor treatments include Hurley (1998), Noë and O'Regan (2001) and Myin and O'Regan (in press).

While sensorimotor theories emphasize perceivers' knowledge of the consequences their actions have for perception, an alternative group of theories that we can loosely term 'action-space' views emphasize perceivers' knowledge of implications, which their perceptual sensitivity to the environment has for possible actions.[3] Consider, for example, Pettit's (2003) account of color looks. For Pettit, for something to look a certain way is for it to empower certain abilities in the perceiver. For example, a tomato's looking red to a perceiver is a matter of its empowering her to, among other things, sort it with red and other similarly-colored objects, sift it from differently-colored objects, and track it across a range of different backgrounds and perceptual situations. Though Pettit restricts his treatment to color looks, his account might be generalized to other aspects of perception. The tomato looks spherical to the perceiver if her perception of it disposes her to sort it with other spherical objects and sift it from differently shaped ones. It is experienced as visually, rather than tactually presented just in case it empowers a suite of abilities in the perceiver that are characteristic of vision rather than touch (sifting and sorting it on the basis of its color, rather than, say, its surface temperature). According to the action-space view, these abilities issue in a conscious experience when they are integrated into the agent's ongoing practical reasoning and deliberation. Thus, to consciously perceive an environment is to grasp the possibilities afforded by that environment for the pursuit of intentional goals and projects[4].

Each theory enjoys strong empirical support[5] and a growing number of advocates. But can either type of appeal to action deepen our understanding of color perception? Intuitively, perceiving color is a passive phenomenon. But this gives enactive theorists good reason to consider it – if they can show that an ineliminable appeal to action is necessary for an account of perception even in the case of color, this must count heavily in favor of enactive views in general. In the following sections, I develop an account of color perception that shows that, at least in the case of our conscious experience of color, the action-space view should be preferred. In the case of color, the sensorimotor links emphasized by the first class of views are real and important, but secondary to the links between perceptual sensitivity and engaged intentional action. Furthermore, considering the relationship between the two views in the difficult case of color can provide us with a framework to understand their relations in other domains.

2. An Action-Space Account: Acting Out Color Space

How might an action space theorist construct an account of color perception in terms of enabled perceptual abilities? A natural starting point is to focus on the range of discriminatory abilities perceptual exposure to a color enables for a perceiver. We have already come across this general idea in Pettit's (2003) account of color looks as powers of objects to enable a range of abilities in a suitable perceiver. One thing that each of Pettit's paradigmatic actions of sifting, sorting and tracking have in common is their reliance on

[3] For example, Clark (2001, 2007), Pettit (2003) and Matthen (2005).

[4] See Ward, Roberts and Clark (ms) for a sustained defense of this position.

[5] See Hurley (1998), ch. 9, Noë and O'Regan (2001) and Hurley and Noë (2003) for detailed surveys of empirical work supporting the sensorimotor view. A major source of empirical support for the action-space view is Milner and Goodale's dual visual systems theory and what it suggests about the function of conscious seeing. See Goodale and Milner (2006) for a summary of the relevant findings, Jacob and Jeannerod (2003) for a more comprehensive survey, and Clark (2007) for a defense of the action-space theory's interpretation of the results.

the subject's ability to make perceptual discriminations of sameness and difference based on sensitivity to the object's color. Ability to track an object based on its color requires an ability to discriminate that object from its background on the basis of its color, as does the ability to sift an object from a class of differently colored objects on the basis of its color. The ability to sort objects into classes of same or similar colors requires the ability to make appropriate discriminations of perceptual similarity.

Following Austen Clark (1993, 2002) and Mohan Matthen (2005, especially ch.11), we can try to ground a theory of color perception in a catalogue of the range of, and relations between, such discriminatory abilities. Two colors are discriminable from each other for a given perceiver if the perceiver's same/different judgments in response to the two colors are correct above chance. Knowing the extent of these abilities for a perceiver allows us to chart the space of colors to which they are perceptually sensitive, and the relations of relative similarity and difference, which hold between those colors.

For example, by presenting a subject with a series of pairs of color chips, each with marginally different hue values, we can move from presenting a subject with a unitary shade of red (a shade which is perceived as containing no traces of yellow or blue) to presenting her with a unitary shade of yellow, while at no stage presenting her with a pair of samples she can reliably discriminate from each other. Likewise, we could present her with a series of pairs with a gradual variation in brightness, and move from presenting a pure white chip to a pure black chip in the same way. In fact, for *any* pair of color samples, we can move from one to the other by a series of presentations of different samples, each one marginally but indiscriminably differently-colored from the last. In this way, we build up a picture of a multi-dimensional color-space, its geometry dictated by the extent of a perceiver's sensitivity to similarities and differences between its constituent shades.

Just as we can construct such a color-space by successive presentation of indiscriminable shades to a subject, we can construct the same space by exploiting the discriminatory abilities the perceiver possesses, by presenting the perceiver with a series of *barely-discriminable* color samples. Such a space needn't be any less fine-grained than the one constructed via indiscriminable samples – a perceiver may not be able to discriminate red 234 from red 235, or red 235 from red 236 (and so on), but still be able to discriminate red 234 from 236, and red 235 from 237 (and so on). Thus, all perceptible shades, and the relations of discriminability between them, are captured in the resultant space. This space is one in which any constituent point can be picked out by specifying its coordinates along three degrees of variation. In the diagram below, an idealized version of the space of colors discriminable to standard human perceivers, the vertical axis represents degree of brightness, the angular coordinate represents degree of hue, and the radial coordinate represents degree of saturation.

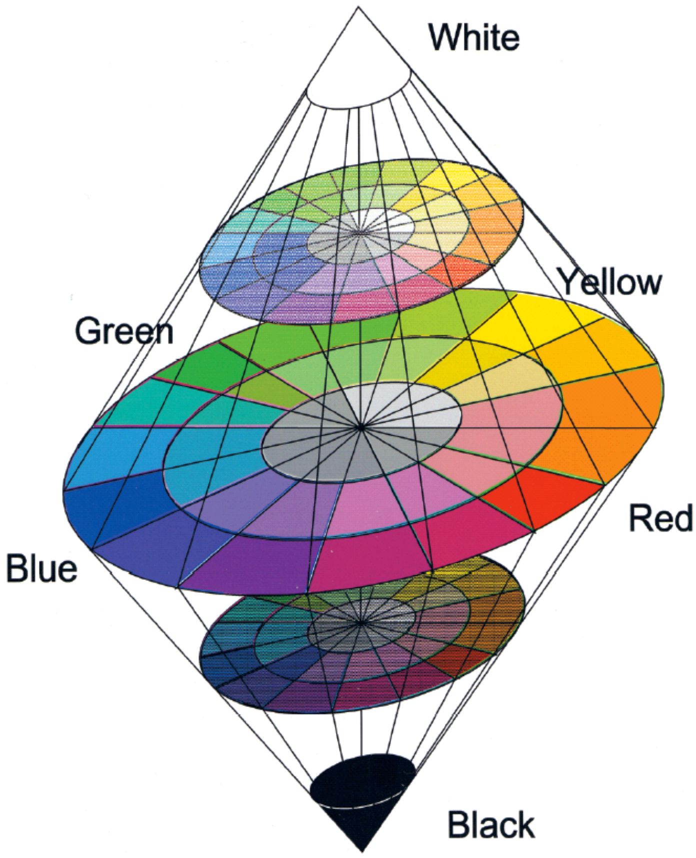

Fig. 1 Any point in color space can be specified by a location in terms of these three coordinates, and the relation between any two points in the space can be given by specifying the vector linking one set of coordinates to the next[6].

The fact that the geometry of the color space is dictated by the range of discriminatory abilities possessed by a perceiver gives action a constitutive role in this account of color perception[7]. Action-space theorists can use the conceptual apparatus outlined above to claim that an agent's experiences of color are explained by her implicit knowledge that a certain range of discriminatory abilities is currently enabled for her. The enabling of these abilities constitutes her occupying a specific point in a complex space of possible enabled discriminatory abilities, the geometry of which is given by the totality of similarity and difference relations obtaining between colors to which the perceiver is sensitive. This is our first pass at an action-space theory of color perception.

A natural question for this proposal is why the enabling of such a range of relationally defined discriminatory abilities should feel like anything at all to a perceiver.

[6] For much more on the precise methods of constructing such a space, including detailed descriptions of the mathematical regularities describing its geometry, and how these are arrived at, see Austen Clark (1993). Matthen (2005, section 2) contains a detailed discussion of sensory ordering in general.

[7] Glossing such an account as action-oriented requires that we count operations of discrimination, comparison and the like as actions. See Matthen (2005, pp. 229-231) for discussion of such 'epistemic actions'. Space doesn't allow a full defense here, but one motivation for such a conception might be the thought that it only makes sense to attribute such discriminatory abilities to a perceiver if their perceptual sensitivity could be put to use in worldly sifting, sorting and grouping tasks.

For example, some blindsight patients can make fine-grained chromatic distinctions between color samples presented in their scotoma when cued by an experimenter, but report doing so in the absence of any experience of the samples' colors[8]. It seems natural to describe this as an instance of enabled discriminatory abilities in the absence of the experience those abilities are supposed to explain. Whether or not the action space view can give a persuasive account of this case will depend on whether it can provide a solution to the problem of the explanatory gap – how *any* physically specifiable state of affairs could be held to explain the presence of a phenomenal experience[9]. Providing and defending such a solution is beyond the scope of our task here, but reflecting on the case of blindsight suggests one plausible option. A promising theory about the difference between standard and blindsighted perceivers is that standard perceivers automatically know that the colored patch in front of them affords matching with such-and-such a range of colors, tracking against such-and-such a range of backgrounds, and so forth – when appropriate, their sensitivity to based-based affordances is automatically put in touch with their intentional goals and projects. This contrasts with our blindsight subject, who retains some perceptual sensitivity to based-based affordances, but requires the intermediary of a prompt from the experimenter before this sensitivity can be put to use in achieving their current goal (in the context of the experiment) of matching or discriminating. Perhaps it is the presence of this automatic interface between the subject's enabled abilities and their abilities to reason, plan, and form intentions in light of their current goals that is crucial for perceptual consciousness[10].

For our purposes here – considering what an account of color perception can tell us about the relations between action and perception – we can suppose that such explanatory gap worries can be met somehow. If so, the theory of based perception under consideration has several attractive features. Due to the way we have drawn up the boundaries and geometry of our based space, every based we can perceptually experience finds a place in our coordinate system of relative discriminability relations. If the action-space theorist can say something plausible about how their account could bridge the explanatory gap, we have an explanans that is isomorphic in structure and richness to our phenomenal explananda, and thus a good candidate for use in a reductive explanation. The theory also has inbuilt resources to guard against inverted spectrum objections – when we attend to the actual structure of human perceptual color-space, we find asymmetries and peculiarities that mean that the space could not be systematically distorted or inverted while preserving the totality of similarity and difference relations between colors that dictate how things appear to the perceiver[11]:

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8 Weiskrantz (1997), cited in Austen Clark (2007).

9 See Pettit (2003) for a general argument that explanatory gap worries about such a strategy are misguided.

10 See Ward, Roberts and Clark (ms.), and the other works cited in footnote 5 for empirically and conceptually motivated defenses of this claim. An alternative account of how the gap might be plugged is Austen Clark's (2007) condition that attention must be directed on the enabled discriminatory abilities for them to become part of the content of a conscious state.

11 Thus we might compare the task of mapping a perceptible colour to a point in colour space to the task of assigning a number to an empty box in a Sudoku grid. The choice of which number to fill in might seem an arbitrary decision, but Sudoku-space (the grid) has been so designed that for any box, there is one and only one number that can go in it while respecting the geometrical rules of the space. Likewise, the discriminability relations that dictate the geometry of colour space permit only one way of mapping a particular colour to a point in that space. See Austen Clark (2004) for more on how this account resists inverted spectrum worries.

> "For example, of the unitary hues, red is the one that can be most saturated. Yellow is the one that when most saturated still most resembles an achromatic stimulus of the same brightness. Red and green are the hues that emerge first out of blackness, but as the lights go up, yellow and blue get brighter quicker." Austen Clark (1997)

The relational structure of our based space also implies that the points in that space are holistically defined in terms of each other (see the Sudoku comparison above), giving the content of color experience a richness and complexity that could be put to use in an explanation of the richness of color experience. And the theory is well-placed to draw on the empirical support for the Hurvich-Jameson opponent-processing model of color[12], a well-confirmed theory about how retinal signals from rods and cones are processed into information about a color's location in an activation space that is isomorphic to the three-dimensional discriminability space to which we have been appealing[13].

However, as we will see in the next section, this approach cannot be the full story about the role of action in color perception.

3. Problems for the Action-Space Account: The Objectivity Color

When we perceive color, it is usually the color of entire object, presented under one of an open-ended range of possible lighting conditions, and displaying some pattern of shadows and highlights across its surface. We almost never perceive an object colored and lit so it presents a uniform appearance across its surface. But it seems that such exceptional cases have just been used as the building materials for the action-space theory of color perception. To chart the geometry of a perceiver's color-discriminability space, we investigated which uniform instances of particular shades she could distinguish from uniform instances of others – perhaps by investigating her abilities to discriminate a range of Munsell chips, presented against a neutral gray background, under fixed lighting conditions. We should wonder whether an account constructed in this manner could do justice to the real, involved and worldly nature of our color perception.

The phenomenon of color constancy is one way of giving this general worry a more specific expression. The surface of my office wall appears to me as a uniform cream color. However, due to the patterns of light and shade distributed over it, a patch of the wall in shadow and a patch of the wall in light will enable a very different range of perceptual discriminations in me. Taken in isolation, I might be disposed to sort a patch of the wall in light with white objects, and a patch in deep shadow with black, for example. But I perceive the wall as neither white, nor black, nor (in the most natural sense) as varying in color across its surface – but as a uniform cream. Likewise, as the sun sets outside my office window and the fluorescent lights overhead become the chief source of illumination, the colors presented by the surface of my desk enable a set of discriminatory abilities in me that differ markedly from those enabled a couple of hours before. However, I have perceived my desk as being identically colored throughout. The point is not that I *judge* my wall or my desk to be uniformly colored despite the color looks they present – rather I *experience* them as uniformly colored, while the fact

[12] See Churchland (2005) for a summary of the H-J model, and the explanatory and predictive advantages of assuming a link between activations in the H-J network and colour experiences.
[13] As we shall see in section 5, the view can also accommodate some cases of colour perception with which other theories struggle.

that they present different color looks over their surface or passage through time is apparent to me only on reflection[14].

The checkerboard illusion also illustrates this worry. In the diagram below, square A looks dark gray and square B looks light gray. But covering up the surrounding squares reveals that they are an identically colored. Thus, taken in isolation, each square enables an identical range of perceptual discriminations of similarity and difference in the perceiver, while appearing very different in color[15].

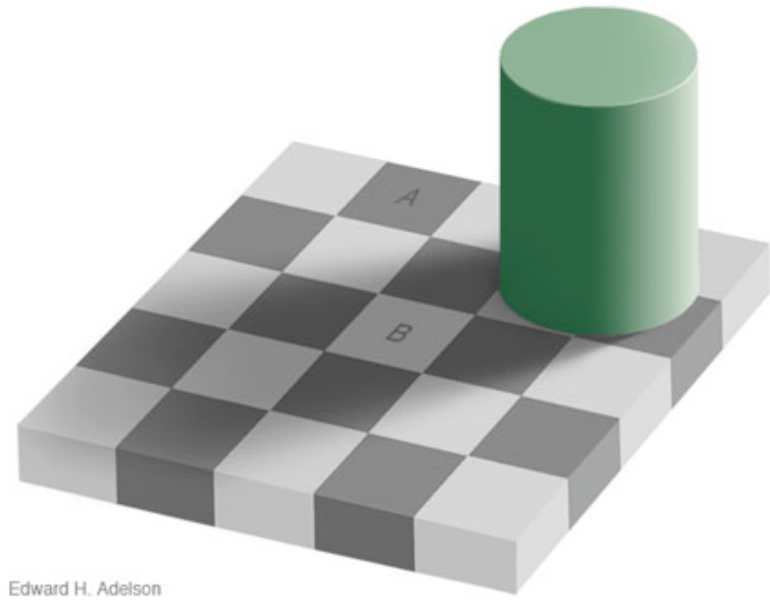

Fig. 2

It seems, then, that we can see something as being uniformly colored while it exhibits differing color-looks, and as differently colored while it exhibits the same color-look. The cases of color constancy and illusion presented above show that an object's presenting a particular color-look to a perceiver is neither necessary nor sufficient for that perceiver to experience it as being a particular color.

A more general worry for the action-space account is that colors, for the most part, are not experienced as subjective, observer-dependent properties, but rather as enduring and objective properties of objects. The ways in which we use colors to categorize, track, and re-identify objects over time illustrate this aspect of our conception of colors. But the action-space account of color has a subjectivist slant – by explaining the color an object appears to a perceiver by reference to the range of chromatic discriminatory abilities enabled in the perceiver, it makes colors 'response-dependent' properties, whose character is dependent on their effects on the subject who perceives them. This is in tension with the objective aspect of the phenomenology of color perception.

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[14] Thanks to Matt Nudds for pressing this objection against the action-space view.

[15] See http://www.lottolab.org/Brightness%20illusions%20page.html# for analogous illusions with different colours, such as orange and brown.

Can the action-space account accommodate the perceived objectivity of color? We cannot objectivise looks-looks via an appeal to the physical properties of colored objects; the physical constitution of an object is compatible with its presenting a wide range of different color-looks under different conditions of contrast, lighting and perceptual adaptation, so we cannot establish a reliable connection between its physical properties and the color-look it presents. In light of this, some theorists[16] build a specification of these conditions into their account, holding that color-looks signal the objective property of being a certain type of physical object, viewed under a certain combination of such conditions. By including a complete specification of the context in which the look occurs, this gives us a link between color-looks and an objective (though complex) property. But it doesn't preserve the objectivity of color experience in the sense we were interested in. Part of the intuition we wished to honor was that color experience seems to present us with properties of external objects that persist over time, and that can be manifest to various perceivers. This cannot be achieved by indexing the objective property we are acquainted with in color experience to a single combination of conditions of the object, its surroundings, its lighting and the perceiver.

Matthen (2005) pursues an alternative strategy, proposing that color-looks acquaint us with the property a colored-object visually *appears* to have. On this account, since we are only put in touch with the way things appear, the object need not be colored as it appears to be, nor need the perceiver believe that the object is so colored. When things are suffused in artificial red light they appear redder than usual without having changed their color, and without the perceiver necessarily having a tendency to believe them to be reddish colored. But the reddish look of the scene still has objective purport since were the perceiver to take her perception at face value, she would take everything around her to be tinted red.

But this proposal neglects what we have just seen - that an object's having a certain color look is consistent with various different ways of appearing to be colored to a perceiver (recall the checkerboard illusion), and it's appearing to be colored in a certain way is consistent with its presenting various different color-looks (recall color constancy). Matthen claims that color-looks put us in touch with the color which things appear to have, but we have seen that something exhibiting a certain color-look is neither necessary nor sufficient for its appearing to be colored in a certain way. The real problem of objectivity facing color-look-based theories of color perception is thus that reflection on the way we perceive the enduring colors of objects suggests that the color-look presented by an object usually fails to determine the color that object appears. In order to do justice to fundamental facts about color perception, then, an account must appeal to more than just color-looks.

4. A Sensorimotor Account: Colors as Ways of Changing Light

Consider our tendency to view an object in various lighting conditions and from various angles when trying to establish its color. Our action-space theorist might suggest that this behavior constitutes our trying to find some optimal lighting condition or angle from which the object will exhibit a color-look corresponding to its true color. But doubt has been cast on the claim that a color-look, taken in isolation, serves as a reliable indicator of any objective color-property a surface possesses. We might also wonder

[16] E.g. Cohen (2000), McLaughlin (2003)

whether it is plausible to think that we could give a principled specification of the optimal conditions for color-perception, or that such conditions exist. Why should the color-look presented by an apple against a backdrop of green leaves in the midday sun be a more objective indicator of its color than the look it presents against a background of brown earth in early evening[17]?

Justin Broackes (1992, 2007) argues for a conception of colors that makes better sense of this tendency, and can deal well with the objections to the action-space theory from the previous section. According to Broackes, colors are ways in which surfaces change the light. Thus, when we move around an object to try and ascertain its color, this behavior aims not at eliciting some 'veridical' color-look from the object, but at gaining a detailed appreciation of the constant way in which its surface modifies various different types of incident light into reflected light.

Similarly, consider the phenomenon of 'aspect shifts' in color perception (Broackes,1992, p. 460). Looking at a book's cover from a particular viewpoint (one from which the visual information received is ambiguous with regards to the way in which it is lit), its color can be experienced as indeterminate between dark blue and black. In this situation the color can be perceived as dark blue at one moment and as black the next, sometimes with these shifts occurring under the intentional control of the perceiver (similar aspect shifts can be achieved when looking at the checkerboard illusion above). But upon further exploration (moving the book with respect to the light-source, or the perceiver with respect to both of these), the cover will be perceived as its proper color, and such aspect-shifts can no longer occur. This can be explained as due to ambiguities in the light reaching the eye regarding the way in which the object modifies light – it might be a black book in good light, or a dark blue book in weak light. As we have seen, the same color-look can signal different objective color properties. Only further exploration can resolve this ambiguity and result in veridical perception the way the book modifies light, and thus of its color[18].

This view of color can deal well with the checkerboard illusion and color constancy cases from the previous section. When we look at the checkerboard, we take square A to be freely illuminated, and square B to be in shadow. Though there is a way in which the two squares share a look, an object can look that way either by being a light gray object freely illuminated, or a dark gray object in shadow. Since we take A to be freely illuminated, and B to be in shadow, we perceive A as light gray and B as dark gray[19]. Thus, the color a surface appears to be is a function not of the color-look presented by the surface, but by the way we implicitly take it to be changing incident into reflected light. Similarly, the different color-looks displayed by different portions of my office wall provide me with information about the constant way the wall modifies different types of incident light into reflected light. This view of matters can make sense

[17] See Hardin (1988) for a detailed discussion of the difficulties facing attempts to specify 'standard conditions' for color perception.
[18] See Broackes (1992, 2007) for further examples and arguments motivating this view.
[19] The effect is no doubt enhanced by our perception of the pattern of the board, and the contrast effects resulting from A's being surrounded by light squares and space, and B's being surrounded by dark squares. However, a range of similar (though slightly less impressive) illusions demonstrate that the effect can be independent of these factors.
See: http://www.lottolab.org/Brightness%20illusions%20page.html#

of the objectivist intuition from the previous section – color perception is perception of a surface's objective property of modifying light in a constant way.

Such a view also enjoys empirical support from recent work by Philipona and O'Regan (POR). For each of a set of 1600 Munsell chips (as well as a large array of naturally occurring surfaces), POR calculated a function of the chip's reflectance properties, in terms of the way the chip's surface transformed the perceptible incident light into perceptible reflected light (with each value of light specified by a three-valued vector). This gives us a function for each colored surface, which tells us, given the properties of the light incident upon it, what the properties of the light reflected from it will be. Some of these functions are simpler than others, changing the value of incoming to outgoing light along one or two dimensions, rather than three. POR chart the relative simplicity of reflectance profiles on a 'singularity index', and find a tight relation between the simplicity of a color's profile and the likelihoods of it being given a unique name, or judged to be a unitary hue. In fact, POR claim to be able to predict which hue a perceiver will judge to be unitary to within the range of a single Munsell chip. These findings provide strong support for the claim that perceiving an object's color is a matter of sensitivity to the way it modifies light, and can explain cross-cultural data concerning color-naming and unique-hue judging behavior that existing theories struggle with[20].

The work of both Broackes and POR has been taken as support for a sensorimotor theory of color perception – a theory that states that the content and character of color perception is determined by perceivers' expectations concerning how their perceptions will change as a result of certain movements[21]. Color is perceived by grasping the ways in which color appearances will vary with movements of the perceiver, and changes in other color-critical conditions[22]. We have just seen that such a view can deal well with the criticisms of the action-space account considered in the previous section. But we shall now see that just as the action-space theory faced a series of problems related to the objective dimension of color perception, the sensorimotor theory we have just sketched has pressing problems accounting for its *subjective* dimension.

5. Problems for the Sensorimotor Account: The Subjectivity of Color

Many of the problems faced by the action-space theory of color stemmed from its difficulty in accommodating the plausible observation that colors are presented to us in perception as objective properties. Perhaps a more puzzling, but equally plausible observation about color perception is the fact that the nature of a color can be at least partially known via transitory and non-standard experiences such as perceiving an after-image, or a neuroscientifically-induced flash of color[23]. If Jackson's (1982) Mary can

[20] See POR (2006) for an account of why traditional attempts to accommodate this data fail. For present purposes, note that there is nothing in the action-space account of colour to suggest which points in discriminability space will be perceived as either unique hues, or colours worthy of naming. It might be thought that appeal to colours at the edge of discriminability space could do this, but these line up neither with unique hues, nor colours likely to be named.

[21] I assume for now that this interpretation is warranted. This assumption will be examined in section 6.

[22] See Noë (2004, pp.129-132) for a sampling of the range of sensorimotor contingencies he believes a perceiver must grasp to see color.

[23] See e.g. Matthen's (2005, pp. 249-250) discussion of Johnston's "Revelation Thesis", and his own "Transparency Thesis" for further motivation of this observation.

induce a momentary illusory perception of a flash of red mist in herself, intuitively this will suffice for her to 'know what it's like' to perceive red, and recognize, remember and imagine objects with that color. It is difficult to reconcile this observation about the ease with which colors can be known with the last section's sensorimotor account. Implicit expectations about the ways in which appearance will vary with movement do not seem to apply to afterimages or flashes of red mist, and neither experience can be plausibly described as involving taking an object to be modifying light in a certain way. Yet it is clear that each case involves an experience of color, albeit an aberrant one.

Hurley and Noë (2006) note a similar problem case for their sensorimotor view in the perception of synesthetic colors. Synesthesia is a condition where one class of perceptions is accompanied by illusory perceptions of a different kind; for example, perceiving letters as accompanied by specific colors (photisms)[24]. As with afterimages, subjects lack sensorimotor expectations about how their photism will change with movement, and as lighting and other perceptually relevant conditions differ. More generally, talk of sensorimotor skills implicated in perceiving a photism again seems inappropriate, since there is no worldly object for the subject to perceptually engage and interact with. Because of the lack of commonality between the sensorimotor profiles of the sensations of veridical and synesthetic red, the sensorimotor view cannot explain their phenomenological similarity.

The sensorimotor view of the previous section also has problems accommodating experiences of 'impossible colors'. For example, fixating for a while on the blue patch below then on the middle of the black square to its right will result in an after-image that appears dark black and simultaneously orange-hued.

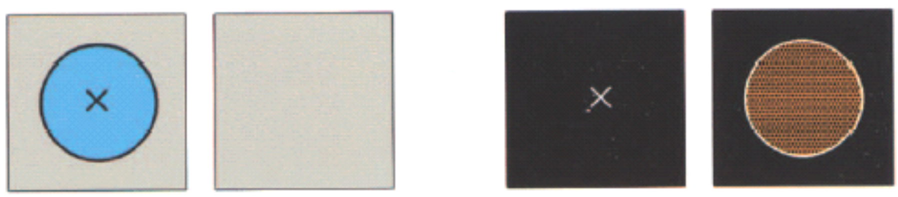

Fig.3

The physics of colored objects precludes there ever being such a color in the world. Not only do we lack sensorimotor expectations about possible variations in our afterimage, the color of the afterimage does not correspond to a possible way an object could modify light. The sensorimotor theorist also faces the challenge of specifying what the sensorimotor contingencies involved in the perception of such a color could be, and explaining how perceivers can have implicit knowledge of these contingencies for colors which they have never before experienced, and would previously have deemed impossible[25].

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[24] See e.g. Ramachandran and Hubbard (2001) for a review.

[25] The figure is from Churchland (2005, p.548). See Churchland for samples which produce impossibly dark versions, impossibly bright versions, and impossibly saturated versions of various different hues, and an explanation of this in terms of opponent-processing models. Recall also the affinity between such models and the action-space account noted in section 2.

Lastly, a less esoteric worry is whether the sensorimotor account can explain the sense in which the squares in the checkerboard illusion appear the *same* color, and my office wall appears *differently* colored across its surface. Though this isn't the way we usually perceive them, it seems undeniable that they sometimes appear this way. Looking at my wall, I can see it as now uniform in color, now varying – how is this possible if my perception of its color only involves my implicitly taking it to be modifying light in a certain way?

Perhaps a sensorimotor theorist should respond that the different ways of perceiving the wall correspond to different ways of taking it to be modifying light. One problem with this line of response is that considering it shows that understanding the sense in which we 'take' an object to be changing the light is problematic. If such 'taking' is supposed to be something that *I know about*, then to the extent that it is plausible to suppose I possess such knowledge, I know the wall to be modifying light in a constant way across its surface, not in a way that differs according to whether a portion is in light or shade. On the other hand, if the way the wall modifies light is supposed to be something that I automatically grasp in perception, how can we explain my ability to attend selectively to the different ways of perceiving it?[26]

Just as the sensorimotor account could readily meet the challenges posed for the action-space account, the action-space account is ideally placed to accommodate the cases considered in this section, each of which poses a problem for, if not a counterexample to, the sensorimotor theory. This is clearest for the cases of color constancy and the checkerboard illusion just considered – recall from section 3 that the action-space account tells us why the portions of my office wall look differently colored, but not why they also appear uniformly colored. To see how it can treat the other cases from this section, consider what it might say about synesthetic colors.

Recall that the action-space account explains the content and character of color perception in terms of the various abilities enabled for an agent by their perceptual sensitivity to the environment. While it is difficult to see how the sensorimotor profiles of synesthetic and veridical colors could overlap, there seem to be significant commonalities between the abilities each type of perception enables in the perceiver. Consider for example Ramachandran and Hubbard's (2001) demonstration of pop-out for synesthetic colors. In these experiments, color-grapheme synesthetes are shown an array of "d"s and "b"s, with the "b"s forming a triangle against the background of "d"s. Because the synesthetes see the letters as different colors, the triangle will quickly "pop-out" for them, whereas non-synesthetes take far longer to discern the location and shape of the "b"s within the "d"s. This suggests that abilities to detect color boundaries and contrasts, and to appropriately integrate and utilize this information in goal-directed action, are present in synesthetic experience as in veridical experience. Similarly, Smilek and Dixon (2002) have demonstrated that color-grapheme synesthetes are slower at identifying a black letter placed against a background of the same color as its photism than against background of a different color, suggesting commonalities between the abilities to easily sift a colored object from an incongruently colored backdrop but not from a similarly colored one for synesthetic and veridical sensations. The abilities

[26] Moreover, we might question whether a response suggesting that we switch between two ways of perceiving the wall is phenomenologically apt – when we have attended to both of them, don't we see both the constancy and the variation in its colour at once? See Noë (forthcoming) for discussion of this topic.

enabled by synesthetic and veridical colors are similar in these and many other ways[27], but this similarity does not extend to perceivers' grasp of their sensorimotor profiles. The action-space account predicts that synesthetic colors will be experienced as similar to veridical colors in proportion to the extent to which the structure of the abilities they enable mirrors that of the abilities enabled by veridical colors, including such priming and interference effects as we have considered. The empirical literature thus far bears this prediction out.

The action-space account treats after-images analogously. As with synesthetic colors, the after-images a perceiver can experience can be located in a multi-dimensional space whose geometry is dictated by the range of discriminations the perceiver can and cannot reliably make between its constituent points. After-images are experienced as similar to veridical colors insofar as they stand in relations of relative similarity and difference to other perceptible after-images that are similar to the discriminability relations that obtain between worldly perceptible colors. As we have seen, the space of perceptible after-images will include colors that could not exist in reality, such as yellowish blacks. The content and character of such impossible colors is likewise explained by the discriminability relations they stand in to the other colors, standard and impossible, that the perceiver can experience. Were it possible to make Munsell chips yellowish-black, and other impossible colors, these colors would have been charted by the procedure outlined in section 2. The fact that such afterimages are both *impossible* and perceptibly *colored* shows that the space of discriminations available to a subject outstrips the space of physically possible colors[28].

In light of all this, we can see that the action-space account can readily accommodate the point about the subjectivity of color with which we began this section. According to the action-space view, an after-image or neuroscientifically-induced flash suffices to give a perceiver knowledge of a color since the perceiver automatically and implicitly grasps both its place in a network of similar and different colors, and the discriminatory and other abilities that are enabled in virtue of this.

6. A Two-Level Enactive Theory of Color Perception

We have considered two types of enactive theory of color perception. Each enjoys strong empirical support, and can give promising treatments of cases that confound the other view. Each, however, also faces serious problems from cases and observations that the other can easily handle. It is natural to wonder whether this situation could be resolved by combining the two views.

The two views are prima facie compatible, and there is even reason to think that the sensorimotor view stands in independent need of something like the action-space view as a component. The sensorimotor theorist claims that we perceive colors by understanding a set of possible ways their appearances could change according to

[27] Other commonalities an action-space theorist might appeal to include similarities in the presence and structure of Stroop and priming effects between synesthetic and veridical colours (Rich and Mattingley, 2002), and the availability for use of synesthetic colours as cognitive aids, as when synesthetes can extrapolate the color of a digit presented in peripheral vision from the color of its photism (Smilek and Dixon, 2002).

[28] Recall that a neat explanation of the extent of these abilities is afforded by taking them to be partly enabled by the H-J opponent processing network (Churchland, 2005).

different viewing conditions. But the sensorimotor theory as it stands gives no account of these changing appearances, only of the higher level property explained by perceivers' grasp of the structures of such possible changes. In response, we can hold that the action-space theory provides the necessary explanation of color appearances.

The sensorimotor theorist might reply that no such independent account is required - the color appearances they appeal to can be accounted for in terms of the systematic relations obtaining between the sensorimotor profiles of colors, rather than in terms of some more basic account. On such a view, a perceiver understands that an object's look would differ a certain way in different viewing conditions by understanding the different sensorimotor profile that the object would look to have in such viewing conditions. This, however, will not work. The major advantage of the sensorimotor theory was that, by identifying an object's color with the objective property of modifying light in a constant way, it could accommodate intuitions and cases that turn on the objective aspect of color perception. But the solution under consideration shifts from viewing color perception as a matter of a perceiver latching on to an objective property via their grasp of sensorimotor relations, to viewing it as a matter of a perceiver taking an object to look as if it has a certain sensorimotor profile, that stands in systematic relations to other sensorimotor profiles the object would look to have in different circumstances. This undermines the objective aspect that made the sensorimotor theory attractive. If the objectivity of the theory is to be maintained, grasping a sensorimotor profile cannot be accounted for in terms of understanding what closely related sensorimotor profiles would look like, since this makes grasp of sensorimotor profiles holistically defined in terms of a perceiver's implicit knowledge of the profiles' relations of apparent similarity and difference in just the way that resulted in a problematically subjectivist account for the action-space theorist. To preserve the objectivity of the account, then, the sensorimotor profile an object possesses cannot be explained in terms of how it and related profiles subjectively appear to the perceiver. An object's having a certain sensorimotor profile must be an objective matter. We might appeal to subjective considerations, such as understanding of the systematic relationships between actual and possible patterns of looks, to explain how a perceiver comes to be able to grasp the objective sensorimotor profile, but such an understanding cannot be what *constitutes* this grasp, on pain of the sensorimotor account surrendering its objective aspect[29].

This point about objectivity, coupled with the sensorimotor theory's inability to give an account of cases with which the action-space account can deal naturally, shows that we need an account of the underpinnings of the changing appearances to which the sensorimotor theory appeals, and the arguments of sections 2 and 5 give us good reasons to think that this account should be in action-space terms. This point, however, also gives us reason to question whether it was correct to think that the work of Broackes and POR motivates a sensorimotor view in the first place.

Our point was that to accommodate objectivist facts about color, the property to which we appeal must be an objective property of the object, not merely a function of the way things appear to the perceiver. The conception of colors as ways of modifying light

[29] A simpler though less decisive way of arguing against this sensorimotor solution would be an appeal to the subjectivist intuition that there must be some appearances that stand behind sensorimotor profiles and need explained – for example, that we can remain neutral on how we take something to be lit, and still think that it looks a certain way. If we are convinced that such a look needs an explanation, we will need to look past the sensorimotor view to find one.

is attractive since it provides a well-motivated way of honoring this point. Nevertheless, how is identifying color with this objective property supposed to support the sensorimotor view? What motivates the sensorimotor theorists' claim that POR's work uncovers "the intrinsic sensorimotor structure of colors"?[30] Their intuitive idea is that knowledge of the way color appearances change with movement and other conditions is necessary to grasp the objective color property an object has. But compare this way of coming to perceive an object's color with the way we come to perceive its shape. The shape of an object can be revealed to me by my understanding of the ways in which its appearance changes, as I move around it. But this does not mean we should have a sensorimotor theory of what it is for an object to have a certain shape, or conclude that the objective property of shape has an 'intrinsic sensorimotor structure'. Rather, shape is an objective property that can be grasped in perception *as a result of* sensorimotor knowledge. Likewise, color is an objective property of objects, perceptual grasp of which can be enabled by sensorimotor knowledge.

As we noted above, an understanding of sensorimotor relations can be how grasp of an objective property is *enabled*, but not how it is *constituted*, on pain of losing the objectivity of color perception. What, then, is constitutive of the perceptual grasp that an object has a certain color property? I propose that just as perceptual grasp that an object displays a certain color look consists in the perceiver's implicit knowledge of the range of abilities her perceptual sensitivity enables in her (section 2), perceiving that an object has a certain objective color-property consists in the perceiver's implicit knowledge of abilities to co-classify, re-identify, and track the object on the basis of her perceptual sensitivity to the property. If this is a tenable option for perceptual grasp of appearance properties, it can be applied to our grasp of higher-level objective color properties too.

The argument of this section has been that the theories of color-perception of sections 2 and 4 need to be combined. Thinking, however, about how the sensorimotor approach could accommodate the objective aspect of color perception, which was supposed to be its strength, led us to reconsider the extent to which the conception of color, which the sensorimotor theorist appeals to, really supports their view. We concluded that understanding sensorimotor dynamics can explain how our sensitivity to objective colors is enabled, but not how it is constituted, on pain of losing the objectivity of color perception. In light of this, I proposed that we should extend our action-space account to perception of objective colors.

We have arrived at a view according to which color perception has both a subjective and an objective aspect. Most of the time, when we perceive color we perceive it as an objective and enduring property, and one that an object can manifestly possess by appearing in one of several different ways, depending on lighting and contrast effects, the perceiver's current state of perceptual adaptation, and so forth. We have good reason to think that this property is the way the object modifies incident into reflected light. According to our account, sensitivity to this property contributes to the character of a subject's experience when that subject understands herself to be empowered to act in various ways – sifting, sorting, classifying, comparing, re-identifying – on the basis of that sensitivity. Nevertheless, there is also a subjective aspect to color perception. This is because we see the color properties an object possesses *by* or *through* seeing patterns in the ways that the object appears to be colored,

[30] (Hurley and Noë, 2006 , p.10).

where ‘appearing to be colored’ in a certain way is compatible with possessing any one of a variety of objective color properties. The action-space account of such color appearance properties follows Austen Clark (1993, 2007) and Pettit (2003) in grounding our experience of such appearances in enabled abilities to sift, sort, track and classify. In contrast to the case where a subject takes herself to be able to act with respect to an object in ways appropriate to its objective color, a subject may take herself to be empowered to act in ways appropriate to an object’s color *appearance* while understanding that a very different set of actions are appropriate with respect to its objective color. A stark instance of such a case would be when a synesthete takes herself to be able to sift, sort and track a grapheme in ways appropriate to green objects, while nonetheless understanding that the grapheme should be sorted with other black characters, is more similar in color to brown than to blue, and so forth. Another such case would be when a subject sees that a spot catching the light on a dark blue vase looks almost white, while still understanding that the surface of the vase is colored uniformly all over, and is more similar in color to black than to white. Coming to see an object as colored in a certain way, involves coming to understand the regularities and significances in the patterns of appearances it presents. In some cases, this might involve having sensorimotor expectancies about the ways the object’s appearance would differ with movement. In some cases, it might not – perhaps in some cases the perceiver’s grasp of how an object would look were it lit differently, or were the perceiver in a different state of adaptation, suffices for perceiving its objective color[31]. Ultimately, however, sensorimotor knowledge is of only instrumental importance for a perceiver’s grasp of the significance of appearance properties – important only to the extent that it contributes to their grasp of the way that an object can be sifted, sorted, tracked, and classified according to the way in which it changes the light.

7. The ‘Agent’ in Magenta, and Beyond

The ‘agent’ in magenta plays a crucial role at two distinct levels, accounting for both its subjective and objective aspects. The account we have arrived at is action-space all the way down – perceiving an objective or apparent color is a matter of a perceiver’s being able to sift, sort, track and otherwise act with respect to that color in a distinctive suite of ways. Knowledge of sensorimotor contingencies can help a perceiver grasp the significance of some pattern of appearances displayed by some object for the way that object should be sifted, sorted, tracked with respect to it’s objective color properties, and thus plays an important, but indirect and enabling role in color perception. We have been led to a plausible theory of color perception, and the conclusion that, at least in the case of color, the action-space view should be preferred to the sensorimotor view.

Additionally, our reflections have provided us with independent motivation for a view of the importance of sensorimotor relations that has been argued for on separate grounds elsewhere (e.g. Andy Clark, (2006)). We have seen that, in the case of color at least, understanding of sensorimotor relations is of only indirect importance, serving to enable the grasp of a distinctive suite of actions that does the truly important work.

[31] Noë (2004, p.169) claims that the way an object changes its appearance changes as a result of the way it’s lit is one of the sensorimotor contingencies relevant to colour perception. However, since movements of the perceiver, object or light source are not necessary for an object to change its appearance as a result of the way it is lit, it seems implausible to suggest that we should understand the relationship between appearance and lighting conditions in terms of patterns of dependence between sensation and movement.

Reflecting on the role of the 'agent' in magenta not only informs our theory of color perception – it has given us cause to consider the relations between action, perception, sensorimotor knowledge, and objectivity in general. Thinking about the case of color has provided us with an argument for an action-space theory of color perception, a view of the relationship between action-space and sensorimotor views, and general conceptual apparatus for considering these themes in other perceptual domains. The next step for the action-space theorist should be to move beyond magenta, to an investigation of the extent to which our conclusions here about action, color, and consciousness can be applied elsewhere.[32]

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